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The Interactive Multisensor Analysis Training (IMAT) System:

An Evaluation of the Airborne Acoustic Mission Course

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The Interactive Multisensor Analysis Training (IMAT) system was developed to address post Cold War ASW training requirements. It is designed to teach the complex conceptual knowledge and cognitive and procedural skills required to reason about the interrelationships among the operating modes of target submarines, the environmental variables that affect sound transmission, and the sensor systems used for detection and tracking. This effort evaluated the application of the IMAT system in the Aviation Antisubmarine Warfare Operator (AW) Class "A" School Airborne Acoustic Mission Course (AAMC). The results showed that (1) the IMAT approach to training produced substantial gains in subject matter knowledge and (2) that AAMC trainees experienced accelerated expertise. These findings indicates that the IMAT-based AAMC should be capable of overcoming the lack of practice opportunities available in today's typical fleet operations.

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Foreword

This evaluation of the Airborne Acoustic Mission Course of the Aviation Antisubmarine Warfare Operator (AW) Class "A" School was conducted under the 6.3 Manpower, Personnel, and Training Advanced Technical Development Program Element 0603707N (Work Unit 063707N.L2335.IM001). The goal of this effort was to evaluate the effectiveness of the Interactive Multisensor Analysis Training (IMAT) System in an operational training environment.

The authors would like to thank AW1 Mark Ringl and AW2 Cory Schick from AW "A" School.

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Summary

Problem and Background

The challenges facing Antisubmarine Warfare (ASW) training in the closing years of this decade are greater than at any time since the early days of World War II. Conditions since the end of the Cold War, and those expected throughout the next decade, impose additional complexity on maintaining our ASW superiority. Russian nuclear submarine technology continues to improve and advanced submarines continue to be built and delivered to their fleet. Concurrently, the proliferation of improved diesel submarine technology to many Third World nations requires that our ASW forces also be capable of conducting operations in the vastly different littoral regions.

When coupled with dramatic reductions in ASW training resources, including at-sea training, this historic change compels the development of training for skills learned previously on-the-job and for skills required in new environments. The training challenge is two-fold: (1) retaining the capability to detect and prosecute nuclear submarines, and (2) expanding our current capability against diesel submarines of the Third World.

The Interactive Multisensor Analysis Training (IMAT) system was developed to address post Cold War ASW training requirements. Specifically, IMAT is designed to teach the complex conceptual knowledge and cognitive and procedural skills required to reason about the interrelationships among the operating modes of target submarines, the environmental variables that affect sound transmission, and the sensor systems used for detection and localization. In addition, IMAT provides extensive training on submarine acoustics and interpretation of sensor system data. The IMAT approach to training is based on recent advances in cognitive psychology and instructional technology. It combines cognitive analytic and curriculum design technology with advanced computer-based graphics and programming technology to deliver state-of-the-art training.

Objective

The objective of this effort was to evaluate the IMAT system based Airborne Acoustic Mission Course (AAMC) at the Aviation Systems Warfare Operator (AW) "A" School.

Method

There were two components to the evaluation. First, a small group of AAMC trainees (N = 11) were compared on a knowledge test with a small number of graduates of the Common Core Acoustic Analysis (CCAA) (N = 7). The AAMC replaced the CCAA course. Second, a larger group of AAMC trainees (N = 35) were evaluated on pretest-posttest knowledge test performance and for accelerated expertise on acoustic mission tasks. Accelerated expertise was evaluated by comparing trainee performance on selected AAMC scenario tasks to a list of skills deemed essential to mission success by six fleet subject-matter experts at supervisory levels. The same subject-matter experts rated those

skills by assessing when typical operators would be able to perform those skills competently, with minimal supervision.

Results

AAMC trainees performed significantly better than CCAA trainees on the knowledge tests. AAMC trainees also showed significant improvement from the AAMC knowledge pretests to the posttests. Finally, AAMC trainee performance on the scenario tasks showed clear evidence of accelerated expertise.

Conclusions

Two conclusions can be drawn from this study. First, the IMAT approach to training, which is based on computer-generated dynamic displays and instructional design and delivery strategies designed to enhance cognition, produced substantial gains in subject matter knowledge. Second, performance on the AAMC scenario tasks support the conclusion that AAMC trainees experienced accelerated expertise. This finding indicates that the IMAT-based AAMC should be capable of overcoming the lack of practice opportunities available in today's typical fleet operations. Overall, the results show that IMAT is a highly effective training system that offers a viable solution for many of the training requirements and challenges faced in the post Cold War world.

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Introduction

Problem and Background

The challenges facing Antisubmarine Warfare (ASW) training in the closing years of this decade are greater than at any time since the early days of World War II. During the Cold War, ASW mission requirements (and the training designed to support those requirements) were driven by the need to combat Soviet nuclear submarines in open ocean environments. The prevailing ASW strategy was designed to detect and prosecute enemy submarines at long ranges, and operations were most often conducted by single ASW units with minimal coordination with outside assets. The relatively benign deep ocean environment and nearly exclusive focus on the Soviet threat resulted in the development of effective and well practiced sensor and weapons tactics. ASW training mirrored that relatively narrow focus, and, combined with frequent real-world encounters, was quite effective in producing competent ASW sensor operators.

Conditions since the end of the Cold War, and those expected throughout the next decade, impose additional complexity on maintaining our ASW superiority. Russian nuclear submarine technology continues to improve, and advanced submarines continue to be built and delivered to their fleet. Concurrently, the proliferation of improved diesel submarine technology to many Third World nations requires that our ASW forces also be capable of conducting operations in the vastly different littoral regions.

Littoral environments introduce added difficulty in optimally employing onboard sensors and weapons tactics. Coastal areas with shallow water, complex bathymetry and bottom topography, heavy shipping, and highly variable environmental conditions impose significant restrictions on traditional deep water tactics. The diesel submarine operating in home waters has the added advantage of familiarity with environmental and topographical anomalies, slow speed operation, and support from own nation defense systems.

When coupled with dramatic reductions in ASW training resources, including at-sea training, this historic change compels the development of different approaches to training for sensor operators. The training challenge has thus become two-fold: (1) retaining the Cold War capability to detect and prosecute nuclear submarines and (2) expanding our current capability against diesel submarines of the Third World.

Traditional ASW Training for Sensor Operators

In the past, ASW training has been based on a balance between schoolhouse and operational training. To become journey level operators, trainees learned the basics in schoolhouse training and then received extensive on-the-job training through supervised practice by experienced fleet crews at-sea. The schoolhouse training focused on memorizing facts, procedures, and large databases of threat intelligence parameters. Trainees were not taught to think about and relate the underlying physics of threats to the environment and to the sensor systems. This approach resulted in graduates who could

perform procedures, but who had difficulty in applying knowledge and principles to solve problems in operational situations. Great reliance was placed on a substantial amount of at-sea experience to transfer the knowledge and skill gained in formal training to operational competency.

Post Cold War ASW Training Requirements

There is now a broad consensus across all four ASW training communities that the combined change in threat, environment, and operating circumstances requires a new training approach.

Current fleet ASW practitioners receive little at-sea operational practice against non-cooperative submarines. As a result, an operator's ability to detect, classify, and track submarine targets will be directly related to the quality of initial training, and to how well those skills are maintained and increased throughout a career. To achieve this level of competence, the limited hours available for both schoolhouse and at-sea training must be used to provide both a solid conceptual understanding of the complex tasks that operators must perform as well as opportunities to practice those tasks under varying real-world conditions.

Achieving these goals will require substantive changes in both schoolhouse and operational training. ASW training must see dramatic modifications to passive acoustic analysis training and substantial expansion of training in active sonar, radar, and electromagnetic sensor systems to enable operators to contribute effectively in a multi-sensor approach to submarine prosecution. Further, the complexity of the acoustic environment in the littoral regions requires a substantial increase in knowledge of the effects of ocean bathymetry on acoustic energy transmission and how that, in turn, affects sensor selection and placement. These training requirements can only be met by applying principle-based training technologies that can provide conceptual knowledge and high fidelity experience to offset the lack of at-sea practice.

The Interactive Multisensor Analysis Training (IMAT) System

Overview: The IMAT system (Ellis & Parchman, 1994; Wetzel-Smith, Ellis, Reynolds, & Wulfeck, 1995) was developed to address post Cold War ASW training requirements. Specifically, IMAT is a classroom based approach to training that is designed to teach the complex conceptual knowledge and cognitive and procedural skills required to reason about the interrelationships among the operating modes of target submarines, the environmental variables that affect sound transmission, and the sensor systems used for detection and localization. In addition, IMAT provides extensive training on submarine acoustics and interpretation of sensor system data.

The IMAT approach to training is based on recent advances in cognitive psychology and instructional technology. It combines cognitive analytic and instructional design technology with advanced computer-based graphics and programming technology. The result is a dynamic graphical interface integrated with state-of-the-art instructor and trainee guides that provides the traditional classroom instructor with a capability to

effectively teach complex cognitive concepts and skills. In the past, achieving this capability has been hampered by limitations in cognitive task analysis, and particularly by limitations in cognitive models. In addition, limitations in computer capabilities have precluded the development of cause and effect representations of highly complex, multi-modal tasks that are required of expert practitioners. Recent developments in cognitively-based training design have demonstrated that models of physical phenomena can be integrated with high resolution graphics to demonstrate the interactive relationships of threat, environment, and system for operator training. The IMAT system extends these technologies to the traditional classroom environment, with specific emphasis on cognitive design models that account for knowledge structure interrelationships. The result is cause and effect training that incorporates visualization of interactive spatial relationships among operators, sensors, and other platforms.

Specifically, for sensor operators, IMAT apprentice training is presented in a mission context with a substantial emphasis on the interactive relationship among environmental factors, threat behavior, and sensor system capabilities and constraints. Because apprentice sensor operators have limited backgrounds in submarine operations, the physics of energy transmission, and in operating complex sensor systems, establishing a good conceptual understanding of the complicated real world interactions is the essential foundation for learning effective sensor operation. Operator trainees are taught to understand that the enemy submarine's mission will largely dictate its operating mode (including course, speed, and depth of operation) and that the operating mode of the submarine defines its vulnerabilities to onboard acoustic and electromagnetic sensors. They are further taught how the relative complexity of the ocean environment will impact detection ranges, search rates, and contact duration. Trainees learn to reason through these interactions in a cause and effect learning process. Multi-dimensional interactions are displayed visually, and the IMAT instruction provides qualitative explanations for the interactions that occur. IMAT presents demonstrations of varying outcomes based upon changes in the threat or environment to promote the development of the principle-based knowledge critical for adaptations to the variations presented in real world situations. Finally, tests of trainee proficiency for IMAT training include questions that require problem solving and understanding causal relationships in addition to the traditional fact and procedural knowledge items.

Research Background

The IMAT system integrates several areas of research on cognition and instruction, including, graphical techniques to promote visualization of invisible phenomena in science teaching, elaborated explanations, contextualized or anchored instruction, and instructional sequencing. The following sections briefly summarize portions of this work.

Scientific Visualization: Scientific visualization has traditionally been used by scientists to explore phenomena and to communicate with other scientists (Bryson, 1994). When used for presentations, researchers select data sets, transforms them and then turn them over to specialized graphic artists to develop images and animation. However, the

end products of this process have not been designed for lay persons or trainees. IMAT aims to bring this technology into specialized technical training.

Research support for scientific visualization as a training strategy comes from the literature on instructional media. Both static and dynamic graphic displays have been shown to facilitate teaching of scientific concepts (Baek & Layne, 1988; Dwyer, 1972; Gropper, 1966; Lumsdaine, Sulzer, & Kopstein, 1961; Rieber, 1990; Rigney & Lutz, 1975; Park & Gittelman, 1992, Wetzel, Radtke, & Stern, 1994). Levie and Lentz (1982), in a meta-analysis of illustrated text studies, concluded that learning and retention is facilitated by illustrations, if the illustrations are directly related to the text. Park and Gittelman (1992) found that subjects trained with dynamic graphics performed better on electronic troubleshooting problems than those trained with static displays. White (1984) used animated computer graphics to successfully teach the basic principles of Newtonian laws of motion and force. IMAT employs a computer based graphical interface to conceptual models of real world phenomena to deliver both static and dynamic graphics in a traditional classroom environment.

Elaborated Explanations: Providing students with elaborated explanations, analogies, etc., about how and why systems, events, and phenomena are structured and function has been shown to facilitate learning and retention. Research on learning skills and on learning from text has shown that elaborated explanations enhance the students' mental models and increase retention (Mayer, 1989; Konoske & Ellis, 1991; Smith & Goodman, 1982). In a series of studies of learning from scientific text, Mayer (1989) found that providing students with a conceptual model increased learning, retention and transfer. The conceptual models in his instruction used both text and diagrams to highlight major objects and actions and the causal relations among them. That is, the models focused on how and why systems work. Smith and Goodman (1982) studied the effects of providing elaborated instructions on learning and performing a procedural assembly task and found that instructions containing functional information resulted in fewer errors. Swezey, Perez, and Allen (1991), in a study on transfer of electromechanical troubleshooting skill, found that some level of generic structure and functional knowledge is required for cross domain transfer. The IMAT system uses elaborated explanations throughout the instruction to (1) clarify complex relationships such as those among water temperature, pressure, depth, and salinity; (2) provide comprehensive feedback for practice exercises; and (3) describe graphically displayed examples.

Contextualized Instruction and Instructional Sequencing: Contextualized or job oriented instruction has been found to be more effective in learning, retention, and performance than topic oriented instruction (Semb & Ellis, 1994; Johnson, 1951; Goffard, Heimstra, Beecroft & Oppenshaw, 1960; Shoemaker, 1960; Steinemann, Harrigan, & VanMatre, 1967; Cognition & Technology Group at Vanderbilt, 1990; Collins, Brown, & Newman, 1989). Further, within a job context, mental model development is facilitated by teaching students to reason about events and phenomena that involve several interrelated variables.

Proper sequencing may play an important role in cognitive skill development. While early research on sequencing showed that with simplified or isolated tasks, different sequences of instructional events made little difference, more recent research and theory suggest that, for complex tasks, sequencing strategies may have significant effects. For example, Reigeluth and Stein (1983) argue that beginning instruction with a condensed "holistic" overview of a task domain leads to better learning than more traditional sequences, which teach isolated topics first and integrate them later. More recently, extreme "constructivist" approaches to instruction (e.g., Duffy & Jonassen, 1991) argue that learners should "sink-or-swim" in a fully elaborated domain. Merrill, Li, & Jones (1990) also argue for a holistic approach to teaching complex domains, but include moderate structure and sequencing recommendations in their approach. Drawing from Reigeluth and Stein (1983), IMAT begins with a simplified overview of target, environment, and sensor system relationships in the context of the jobs and tasks performed by operators and tacticians. This context is revisited throughout the IMAT course to reinforce the reality that trainees are learning to do a job, not memorize a list of topically related facts.

AW "A" School —The Airborne Acoustic Mission Course (AAMC)

In each of these areas, little experimental work has been done on how well the findings generalize to instruction delivered using simulation and graphical-interface-based training technologies. Furthermore, there are almost no larger efforts which evaluate the integration of these approaches into an overall strategy. The current effort tests the hypothesis that the IMAT system, which represents an integrated combination of these approaches, offers a potent learning environment for promoting acquisition of the complex knowledge and skills involved in sensor-system operation. Specifically, this report documents the implementation and evaluation of the IMAT AAMC in the AW "A" School at NAS Pensacola, FL. The AAMC replaced the five and one half week Common Core Acoustic Analysis (CCAA) course that was taught at the Fleet Aviation Specialized Operations Training Groups Pacific (North Island Naval Air Station, San Diego, CA) and Atlantic (Naval Air Station, Jacksonville, FL). The CCAA training used a topical approach to analysis methods and a linear progression through a large number of submarine examples. Evaluation was based on a written knowledge test (multiple choice) and analysis of static LOFAR displays. Neither the written nor performance exams presented the material in an operational context. None of the instruction was focused on individual skills in target or environmental research, resource use, or personal preparation for detecting, localizing, and tracking submarine contacts.

In contrast, the AAMC builds on previous "A" School training by presenting opportunities to learn and practice AW core knowledge and skills in a mission context. The course is based on nine scenarios. Each centers on operations against a specific submarine in a well defined environment. Examples of both targets and operating areas were chosen to represent a wide range of missions, submarine engineering sophistication, oceanographic characteristics, and sensor capabilities. The instructional design presents the first mission scenarios in highly structured ways with considerable instructor

mediation. As learners progress through the course, they are expected to perform more autonomously until the final scenario, which is almost entirely unmediated.

In addition to the application of oceanographic concepts and acoustic analysis skills, the AAMC places considerable emphasis on personal preparation for mission performance. In the same scenario concept, learners use fleet publications and other materials to research both the target and environment. These preparatory skills are directly transferable to squadron duties and enable the users to "ramp up" after periods of ASW inactivity.

In summary, the IMAT based AAMC represents a significant change from the CCAA instruction. The course length was increased from 212 to 230 hours, and there were extensive changes in both the instructor and trainee guides, which were redesigned using IMAT criteria to provide both elaborated explanations and more contextualization. Furthermore, the IMAT graphical interface was used to provide the classroom instructor with both static and dynamic displays of important concepts and relationships, including, LOFAR displays, submarine operating characteristics, submarine equipment acoustic profiles, and target analysis and classification. All of these changes resulted in a course that emphasized learning cognitive skills and complex relationships instead of memorizing factual information, which was the focus of the CCAA course.

Objective

The objective of this effort is to evaluate the implementation of the AAMC with respect to knowledge acquisition and accelerated expertise on acoustic mission tasks.

Method

Design

There were two components to the evaluation. First, a small group of AAMC trainees (N = 11) were compared on a knowledge test with a small number of graduates of the Common Core Acoustic Analysis (CCAA) (N = 7). Second, a larger group of AAMC trainees (N = 35) were evaluated on (1) knowledge acquisition during the course, which was assessed by a pretest and posttest comparison on the course knowledge tests and (2) accelerated expertise on ASW mission skills.

To assess accelerated expertise, six senior enlisted AW subject matter experts reviewed a profile of skills and tasks taught in the scenario exercises of the AAMC. First, they were asked to rate each skill for importance to mission accomplishment and then were asked to estimate the length of time required for apprentice AWs to become proficient in each skill. AAMC trainees were scored on each skill during a course scenario exercise. The time to proficiency ratings were then used to estimate the degree of accelerated expertise for each skill.

Subjects

For the comparison between the AAMC and CCAA course, the subjects were 11 graduates from the AAMC and 7 graduates from the CCAA course. For the pretest and posttest and accelerated expertise comparisons, the subjects were 35 trainees from two AAMC classes. The six subject matter experts responding to the mission skills survey were all experienced air crew supervisors with multiple sea tours in fixed-wing aircraft (VP and VS). Two of the subject matter experts had helicopter experience. One subject matter expert was an AWCS, four were AWCs, and one was an AW1.

Mission Skills Survey

The six subject matter experts were given a list of skills taught in the AAMC course and were asked to rate each skill for mission importance and time to proficiency. For mission importance the experts were asked, "To what extent are each of the following skills important for mission success?" They rated each skill on a four-point scale: (1) Unnecessary; (2) Nice to Have; (3) Probably Required; and (4) Absolutely Required. Table 1 displays the list of skills. The skills listed in Table 1 are the skills taught in the laboratory based scenario exercise portions of the AAMC. A number of additional skills are taught in the classroom portion of the course and are not listed in Table 1.

Table 1

AAMC Course Skills and Behaviors

Skill or Behavior
Call initial contact.
Select appropriate signature components for tracking.
Record time, frequency, sonobuoy, and appropriate notes for all acoustic signature components of interest.
Recognize and report intermittent and transient acoustic sources.
Recognize and report speed-related components.
Recognize and report closest point of approach, from weak indicators to obvious ones.
Calculate speed from propulsion-related components.
Report speed changes in a timely manner.
Report and record contact and major component losses.
Prepare an off-station report including classification of target of interest with justification based on acoustic signature.

For time to proficiency the experts were asked "In your experience, at which point would you expect an AW "A" School graduate to be fully proficient in these skills (through a combination of training and experience)? They answered this question by rating each skill on a 6 point scale representing events in a career progression: (1) Upon Reporting, (2) Before 1st Deployment, (3) After 1st Deployment, (4) After 2nd Deployment, (5) After 1st Sea Tour, and (6) After 2nd Sea Tour.

Knowledge and Performance Tests

Two knowledge tests were given in the AAMC: one following the units on nuclear submarines and one following the units on diesel submarines. The knowledge tests assessed information required for performing the scenario exercises. For the comparison between AAMC and CCAA courses, trainees in both courses were given the AAMC knowledge test on the nuclear units. For the pre-post comparisons for the AAMC, trainees were first given the nuclear and diesel tests before they began the course and then were given the same tests again at the scheduled time during the course.

Seven scenario exercises were given as performance tests in the AAMC. Trainee performance on the final nuclear and diesel scenarios was used to evaluate accelerated expertise on ASW mission skills. The scenarios were designed to both train and test the mission skills listed in Table 1. The final scenarios for both nuclear and diesel submarines were weighted most heavily for final course grade. These scenarios also placed more emphasis on skill application than on knowledge.

Results

CCAA and AAMC Knowledge Test Performance

A t-test compared CCAA and AAMC trainees on the knowledge test for the nuclear units. (Knowledge test data for the diesel units and performance test data for the scenarios were not available for CCAA trainees because the course was discontinued.) The AAMC trainees scored significantly higher than CCAA trainees ($p < .01$). The mean score for AAMC trainees was 69.27 ($SD = 7.94$) and the mean score for CCAA trainees was 53.43 ($SD = 7.52$).

AAMC Pretest and Posttest Performance

Two tests compared the pretest and posttest performance of AAMC trainees on the diesel and nuclear knowledge tests. For both tests, posttest performance was significantly higher than pretest performance ($p < .01$). Table 2 presents the means and standard deviations for these analyses.

Table 2

Means and Standard Deviations for the Diesel and Nuclear Pretests and Posttests

Knowledge Test	Pretest	Posttest
Diesel	3.34 $SD = 2.87$	89.66 $SD = 6.71$
Nuclear	13.76 $SD = 9.18$	82.77 $SD = 8.91$

Mission Skills Survey

For the mission skills survey, a statistical consensus was determined for each skill. This was done by calculating the skill's mean rating score and assigning the skill scale rating closest to the mean. Table 3 displays the consensus scale rating and mean rating score for each skill. Table 2 shows that all skills received the highest mission importance consensus rating.

Table 3

Consensus Ratings for AW Experts on Mission Importance and Time to Proficiency and Mean Rating Scores for Each Skill/Behavior

Skill or Behavior	**Mission Importance (No. of Raters = 6)**	**Time to Proficiency (No. of Raters = 6)**
Call initial contact.	Absolutely required Mean = 4.00	After 1st deployment Mean = 2.66
Select appropriate signature components for tracking.	Absolutely required Mean = 4.00	Before 1st deployment Mean = 2.33
Record time, frequency, sonobuoy, and appropriate notes for all acoustic signature components of interest.	Absolutely required Mean = 3.83	After 1st deployment Mean = 2.66
Recognize and report intermittent and transient acoustic sources.	Absolutely required Mean = 3.66	After 1st deployment Mean = 3.33
Recognize and report speed-related components.	Absolutely required Mean = 3.66	After 1st deployment Mean = 3.33
Recognize and report closest point of approach, from weak indicators to obvious ones.	Absolutely required Mean = 4.00	Before 1st deployment Mean = 2.00
Calculate speed from propulsion-related components.	Absolutely required Mean = 4.00	Before 1st deployment Mean = 2.00
Report speed changes in a timely manner.	Absolutely required Mean = 4.00	Before 1st deployment Mean = 2.16
Report and record contact and major component losses.	Absolutely required Mean = 4.00	Before 1st deployment Mean = 2.33
Prepare an off-station report, including classification of target of interest with justification based on acoustic signature.	Absolutely required Mean = 3.83	After 1st deployment Mean = 2.66

AAMC Accelerated Expertise

To evaluate accelerated expertise for AAMC trainees, trainee performance on the final nuclear and diesel scenarios was scored for each of the mission skills listed in Table 1. Course instructors scored trainees on a 5 point scale: (1) Not Proficient, (2) Below Average Proficiency, (3) Average Proficiency, (4) Above Average Proficiency, and (5) Highly Proficient. Mean scores for all the skills were three or better.

The scale consensus rating for time to proficiency and the mean performance scores for the final diesel and nuclear scenarios for each skill are displayed in Table 4. The mean performance scores for trainees on skills rated as full proficiency achieved "Before 1st Deployment" was 3.66 for the nuclear scenario and 3.43 for the diesel scenario. The mean performance scores for trainees on skills rated as full proficiency achieved "After the 1st Deployment" was 3.98 for the nuclear scenario and 3.82 for the diesel scenario." These scores show above average proficiency for all tasks and offer clear evidence of accelerated expertise. That is, the skill level of average AAMC graduate is above average on tasks that are normally acquired in follow-on training and after the 1st deployment.

Table 4

Nuclear and Diesel Scenario Skill Scores for AAMC Trainees

Skill or Behavior	Time to Proficiency Consensus Rating	Nuclear Score	Diesel Score
Call initial contact.	After 1st Deployment	4.66	4.23
Select appropriate signature components for tracking.	Before 1st Deployment	4.40	4.43
Record time, frequency, sonobuoy, and appropriate notes for all acoustic signature components of interest.	After 1st Deployment	3.74	4.17
Recognize and report intermittent and transient acoustic sources.	After 1st Deployment	3.00	3.00
Recognize and report speed-related components.	After 1st Deployment	3.94	3.00
Recognize and report closest point of approach, from weak indicators to obvious ones.	Before 1st Deployment	4.37	3.71
Calculate speed from propulsion-related components.	Before 1st Deployment	3.57	3.00
Report speed changes in a timely manner.	Before 1st Deployment	3.00	3.00
Report and record contact and major component losses.	Before 1st Deployment	3.00	3.00
Prepare an off-station report including classification of target of interest with justification based on acoustic signature.	After 1st Deployment	4.54	4.71

Conclusions

Two conclusions can be drawn from this study. First, the IMAT approach to training, which is based on computer-generated dynamic displays (scientific visualization) and instructional design and delivery strategies designed to enhance cognition, produced substantial gains in subject matter knowledge. Second, performance on the AAMC scenario tasks support the conclusion that AAMC trainees experienced accelerated expertise. This finding indicates that the IMAT-based AAMC should be capable of overcoming the lack of practice opportunities available in today's typical fleet operations. Overall, the results show that IMAT is a highly effective training system that offers a viable solution for many of the training requirements and challenges faced in the post Cold War world.

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